CLAIMS

What is claimed is:

1. An ultra-high density data storage device using phase-change diode memory cells, and having a plurality of emitters for directing beams of directed energy, a layer for forming multiple data storage cells and a layered diode structure for detecting a memory or data state of the storage cells, the device comprising:

a phase-change data storage layer capable of changing states in response to the beams from the emitters, comprising a material containing copper, indium and selenium.

2. The storage device according to Claim 1, wherein the phase-change data storage layer is doped with gallium.

3. The storage device according to Claim 2, wherein the data storage layer comprises a $Cu(InGa)Se_2$ material.

4. The storage device according to Claim 2, wherein the data storage layer comprises a $Cu(In_{1-x}Ga_x)Se_2$ material.

5. The storage device according to Claim 1, wherein the data storage layer comprises a layer of the layered diode structure.

6. The storage device according to Claim 1, further comprising a second layer adjacent to the data storage layer to form the diode structure.

7. The storage device according to Claim 1, wherein the second layer comprises a CuInSe material.

8. The storage device according to Claim 7, wherein the second layer is doped with gallium.

9. The storage device according to Claim 1, further comprising a silicon substrate adjacent to the second layer.

10. The storage device according to Claim 1, wherein the diode structure is a detection element in one of a group of data storage detection devices, selected from the group consisting of photovoltaic devices, cathodovoltaic devices, photoluminescent devices and cathodoluminescent devices.

11. A data storage array of multiple thin film layers adapted to form a plurality of data storage cell diodes comprising:

a silicon substrate;

a first diode layer comprising a material fabricated over the silicon substrate; and

a second diode layer of phase-change material, fabricated on the first diode layer to form a diode junction with the second diode layer, the phase-change material containing copper, indium, selenium and gallium.

12. The data storage array according to Claim 11, wherein the second diode layer of phase-change material comprises a $Cu(InGa)Se_2$ material.

13. The data storage array according to Claim 11, wherein the second diode layer of phase-change material comprises a $Cu(In_{1-x}Ga_x)Se_2$ material.

14. The data storage array of claim 11, wherein the second diode layer is phase changeable between first and second states, in response to a directed energy beam.

15. The data storage array of claim 15, wherein the first and second states are amorphous and crystalline states.

16. The data storage array of claim 15, wherein the first and second states are different crystalline states.

17. The data storage array according to claim 11 wherein the first diode layer comprises a CuInSe material.

18. The data storage array according to claim 11, further comprising a field layer fabricated on the substrate.

19. The data storage array according to claim 19, wherein the field layer is composed of molybdenum.

20. The data storage array according to claim 11, further comprising a voltage source connected to the array on opposite sides of the diode junction to impress a voltage across the junction so that a current flows through the junction in response to a directed energy beam and is representative of a data state of a data storage cell diode.

21. A method of forming a diode structure for a phase-change data storage array, having multiple thin film layers adapted to form a plurality of data storage cell diodes, comprising:

depositing a first diode layer of material on a substrate; and

depositing a second diode layer of phase-change material on the first diode layer, the phase-change material containing copper, indium and selenium.

22. The method of claim 21, wherein the phase-change material is doped with gallium.

23. The method of claim 22, wherein the phase-change material is a $Cu(InGa)Se_2$ material.

24. The method of claim 22, wherein the phase-change material is a $Cu(In_{1-x}Ga_x)Se_2$ material.

25. The method of claim 21, wherein the steps of depositing the first diode layer and the second diode layer are done in the same vacuum system.

26. The method of claim 21, wherein the steps of depositing the first diode layer and the second diode layer are done by electrodeposition.

27. The method of claim 21, wherein the steps of depositing the first diode layer and the second diode layer are done by sputtering.

28. The method of claim 21, further comprising depositing a field layer on the substrate prior to depositing the first diode layer.

29.. The method of claim 21, wherein the field layer is deposited by sputtering.

30. The method of claim 21, wherein the steps of depositing the first diode layer and the second diode layer are done by performing elemental evaporation in vacuum.

31. The method of claim 21, wherein the steps of depositing the first diode layer and the second diode layer are done by sputtering.